APPLICATIONS PAPER

Objects-based Image Analysis for Mapping Natura 2000 Habitats to Improve Forest Management

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Abstract

Natura 2000 is a European network of protected areas established under the Habitats Directive (92/43/EEC). According to the Habitats Directive, habitat maps must be periodically updated, which requires the development of cost- and time-efficient mapping practices. In this study, we propose a methodology for habitat mapping using very high spatial resolution (QuickBird) images with Object-Based Image Analysis (OBIA). We classified five segmentation levels: level 5 incorporated the prior knowledge of the study area into the analysis; level 4 and 1 were used to identify arable areas and land covers, respectively. The information contained in levels 1, 4, and 5 was then combined to classify plant species in level 2. Finally, habitats were classified in level 3 using level 2 class-related features. The habitat map obtained had an overall accuracy of 86.3 percent. Classification accuracies were higher for tree- and pasture-dominated habitats than for shrub-dominated habitats.

Introduction

Natura 2000 is a European network whose main goal is to preserve the favorable conservation status of natural habitats and species, thereby ensuring European biodiversity (Velázquez *et al.*, 2010). This network includes Special Protection Areas for birds (Birds Directive 2009/147/EC) and Special Areas of Conservation for habitats (Habitats Directive 92/43/EEC) to provide endangered animals, plants, and habitats with increased protection (Hernando *et al.*, 2010). According to the regulations, member states have to report on the actual area, the range, the quality, and the future prospects for each habitat type every six years (Rojas-Briales, 2000). However, one of the main constrains for the implementation of the Natura 2000 network is the lack of consistent information on type, location, size, and quality of habitats (Weiers *et al.*, 2004). In fact, the mapping of habitats is of major importance for assuring their conservation status through appropriate silvicultural management (Förster and Kleinschmit, 2008). For this purpose, land-cover and habitat maps have been developed at the European and National level. The CORINE (Coordination of Information on the Environment) land-cover map was created in 1987, and it was the first total coverage map in Europe. It was created using Landsat Thematic Mapper (TM) and SPOT imagery, and it is updated every 10 years. In addition, the European Environmental Agency also developed the EUNIS (European Nature Information System about species and habitats types) key, which includes a denominator compatible with the Habitats listed in Annex I of the Habitats Directive (Weiers *et al.*, 2004; Bock *et al.*, 2005b).

Object-Based Image Analysis (OBIA) emerged as an alternative to pixel-based classifications, which largely neglect shape and context aspects of the image information, which are important features for human interpretation (Baatz *et al.*, 2008; Lang, 2008; Blaschke, 2010). OBIA has yielded positive results when applied to very high resolution (VHR) imagery for mapping biotopes, fuels, riparian zones, rangelands, or wildland-urban interface areas, forest vegetation, and forest stands, among other examples (Laliberte *et al.*, 2007; Mallinis *et al.*, 2008; Arroyo *et al.*, 2010; De Chant *et al.*, 2010; Petr *et al.*, 2010; Tiede *et al.*, 2010). From an ecological point of view, it is also more appropriate to analyze image objects as opposed to single pixels, because habitats consist of patches (rather than individual elements) and therefore, these patches are better analyzed in the image by means of OBIA (Laliberte *et al.*,

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